

NEW SPECIES AND IMMATURE INSTARS OF CRANE FLIES
OF SUBGENUS *TIPULODINA* ENDERLEIN FROM SULAWESI
(INSECTA: DIPTERA: TIPULIDAE: *TIPULA*)

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ABSTRACT

Tipula (*Tipulodina*) *nettingi* and *T. (T.) phasmatodes*, the first two species of subgenus *Tipulodina* recorded from Sulawesi, Indonesia, are described and figured. The external anatomy of the last instar larva and pupa of *T. nettingi* is described and illustrated. Comments concerning habitats of the larva and the mate-searching behavior of the adult male are provided.

KEY WORDS: *Tipulodina*, Tipulidae, larva, pupa, Sulawesi

INTRODUCTION

Crane flies of the subgenus *Tipulodina* (Enderlein, 1912) (Diptera: Tipulidae: Tipulinae: *Tipula*) have a predominantly Oriental distribution; of the 47 recorded species, 42 are strictly Oriental (Alexander and Alexander, 1973), with two species occurring in the Australasian region (Oosterbroek, 1989), and at least three species recorded from northern China and Japan (Ishida, 1956; Oosterbroek and Theowald, 1992). There is also one undescribed species from Korea (George Byers, personal communication). In Indonesia, nine species of this subgenus have been reported from Borneo, Java, and Sumatra. In 1985, two undescribed species of *Tipula* (*Tipulodina*) were collected on Sulawesi, the first record of this subgenus from that island. Species of *Tipulodina* can be separated morphologically from those of other subgenera of *Tipula* by having a conspicuous dark mark at the tip of the wings on the costal margin, and by having elongate legs with snowy-white rings on the femora, tibiae, or tarsi. *Tipulodinodes* and a few species of *Dolichopeza* also exhibit the white rings on the tarsi, but can be separated from *Tipulodina* by absence of the dark mark at the tip of the wings.

A pupal skin from Salatiga, Java, was sent to de Meijere and subsequently determined and briefly described as *Tipula* (*Tipulodina*) *pedata* Wiedemann (de Meijere, 1911). This was later translated and commented upon by Alexander (1915). A female pupa of an unknown species (Alexander, 1931) and larvae of two undetermined species (Alexander, 1931; Savchenko, 1983), all from Java, also have been supposed to belong to the subgenus *Tipulodina*. Both Alexander and Savchenko were guarded in their conclusions because of the lack of associated adult flies. Based on the current investigation, it is clear that the larval specimens involved in both Alexander's and Savchenko's papers show significant differences from the larva of the new species in having relatively small spiracular discs, unequal spiracular lobes, and six anal gills. The pupal specimen from Buitenzorg, Java (Alexander, 1931), does agree with pupae of the new species. However, a

Submitted 26 February 1998.

pupal specimen from Tallulah Falls, Georgia (Alexander, 1915:185), most likely belongs to *Leptotarsus (Longurio) testaceus* Loew (Gelhaus and Young, 1995).

The successful rearing of several larvae into adults allows the present study to contribute the first complete descriptions and illustrations of the last instar larva and pupa for the subgenus *Tipulodina*, as well as additional knowledge regarding the biology and behavior of the larvae and adults. Terminology of larval, pupal, and adult characters follows that of Byers (1961), McAlpine (1981), and Gelhaus (1986).

SYSTEMATICS

Tipula (Tipulodina) nettingi Young, **new species** (Fig. 1A, B, E)

Description.—Body length: male, 17 mm; female, 27 mm. Wing length: male, 19 mm; female, 22 mm.

Head: rostrum short, grayish brown, sides with dark brown median stripe. Nasus distinct, about two-thirds length of rostrum. Occiput brown with dark brown median line extending from base to anterior vertex. Palpi yellowish brown. Antenna 9 mm in male, 4.5 mm in female; antenna with scape, pedicel, and first flagellomere pale brown, other flagellomeres dark brown, basal enlargements conspicuous with four to five verticils; in female, verticils longer than corresponding flagellomeres.

Thorax: pronotum dark brown medially, yellowish brown laterally. Prescutum yellowish brown with three distinct dark brown stripes; central stripe broad, with dark, narrow median line; lateral stripes shorter, extending from pseudosutural fovea to transverse suture. Scutum yellowish brown with dark brown center, bordered with brown. Scutellum and parascutellum grayish brown, former with dark brown median vitta. Postscutellum grayish brown. Wings grayish subhyaline, with dark brown area including apex in outer radial cells and with conspicuous dark seams on anterior and posterior cord; outer medial veins narrowly seamed with brown; stigma dark brown, confluent with brown seam at cord; a faint light brown quadrate spot before middle of cell *bm* along vein *CuA*. Halteres dark brown. Legs with coxae and trochanters light yellow; femora brownish yellow with short, conspicuously darkened apex; outer one-fifth of fore femora whitened to form long diffuse ring; tibiae brownish black with long, white, subterminal ring, subequal in length to darkened apex; basitarsi white with dark brown proximal and distal ends; remaining tarsomeres white except dark brown pretarsi.

Abdomen: terga chestnut brown with brownish black subterminal band, extreme posterior borders narrowly yellow; sterna yellowish brown.

Male hypopygium: external structures as in Figures 1A and B. Posterior border of tergum IX slightly emarginate, with small, median glabrous lobe; broadly rounded, lateral lobes of tergum setiferous. Outer dististyle oval, flattened. Inner dististyle with beak slender in dorsal aspect, directed anteriorly; lower basal lobe of inner dististyle fingerlike, with long, dark apical setae; outer basal lobe of inner dististyle small, hook-shaped, apex a sharp black spine directed inward. Sternum VIII with posterior border short, rounded sides.

Ovipositor: external structures as in Figure 1E. Cerci slightly longer than tergum X, broad at base, tapered posteriorly toward slightly upcurved apex. Basal portion of cerci expanded dorsally. Hypovalves extending to about half length of cerci. Sternum IX with distinct, sclerotized lateral lobes and median fused valvulae. Sternum X with long setae.

Type Material.—Holotype: male, Carnegie Museum of Natural History (CMNH). Verbatim text of three pin labels: INDONESIA Sulawesi Utarra Dumoga-Bone N. P. 6 Sept. 1985 Coll. Chen Young / R2 Toraut 211 m PROJECT WALLACE / HOLOTYPE *Tipula (Tipulodina) nettingi* Young [red paper]. Paratypes: three males and one female, topotypic, males collected on 25 August and 3 September 1985; female emerged on 4 September 1985.

Other Material.—One male specimen, topotypic, emerged on 3 September 1985, preserved in 80% ethanol and deposited in CMNH.

Etymology.—This species is named in honor of the late Dr. Graham Netting for his wisdom and foresight in establishing an endowed fund for research at the Carnegie Museum of Natural History. This fund has greatly aided field research programs in entomology over the years.

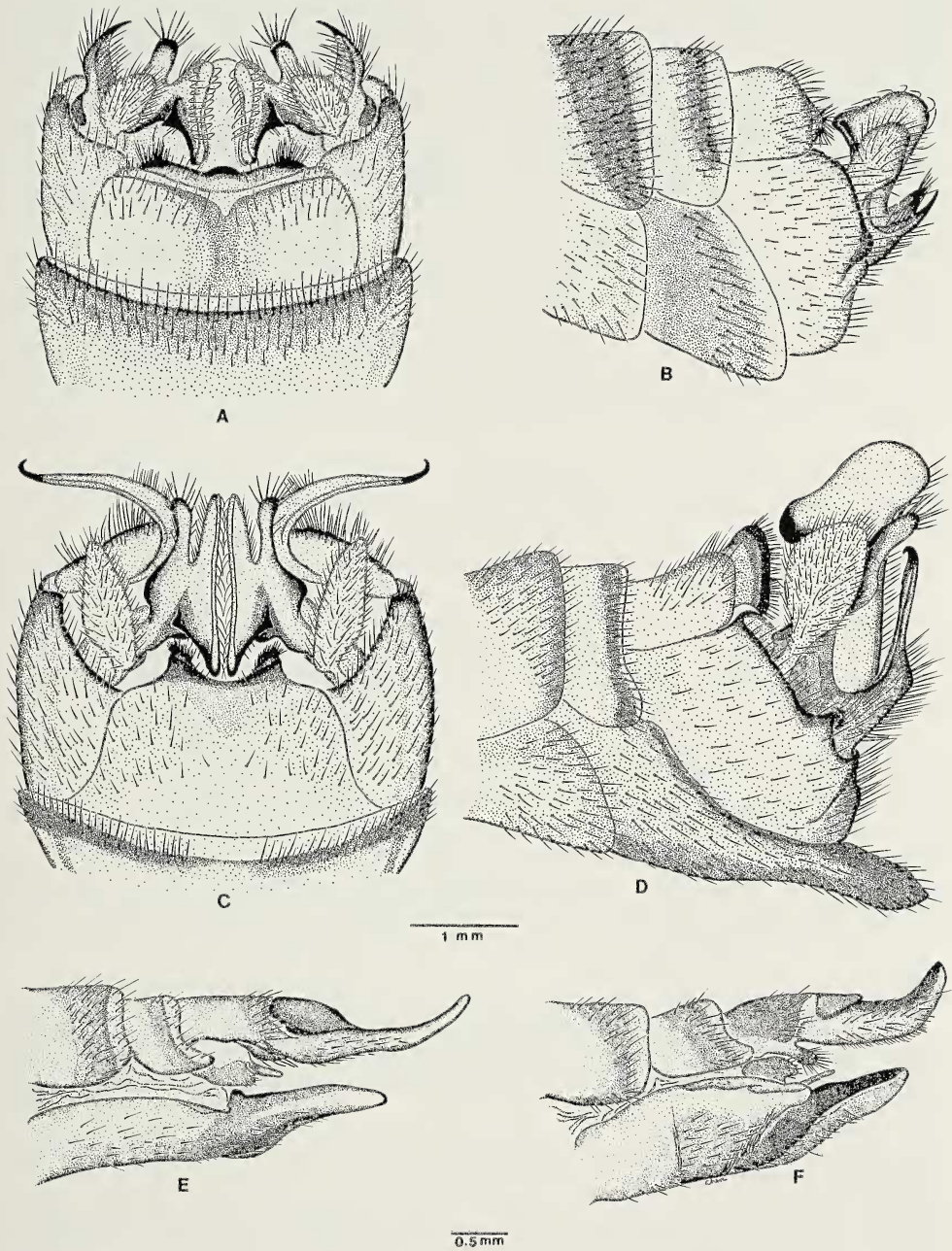


Fig. 1.—A, B. Adult male hypopygium of *Tipula (Tipulodina) nettingi*: A, dorsal view; B, lateral view. C, D. Adult male hypopygium of *T. (T.) phasmatodes*: C, dorsal view; D, lateral view. E. *Tipula (T.) nettingi* female ovipositor, lateral view. F. *Tipula (T.) phasmatodes* female ovipositor, lateral view.

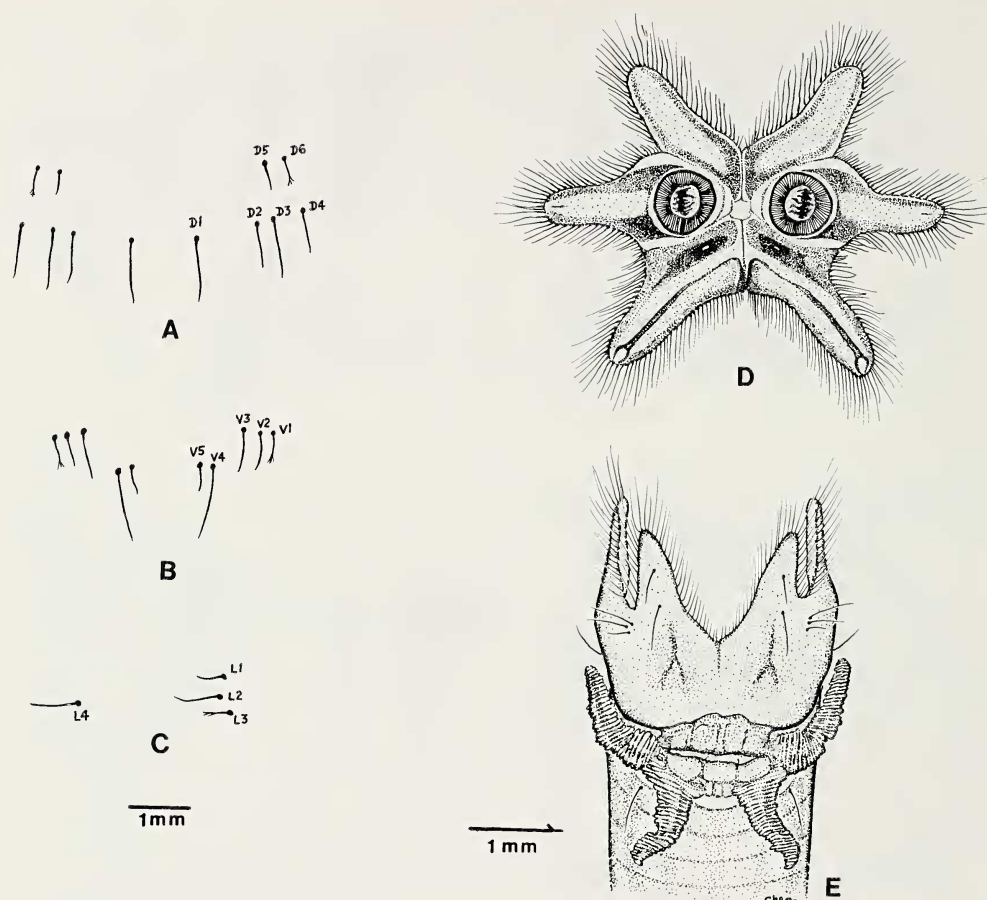


Fig. 2.—Larva of *T. (Tipulodina) nettingi*. A, C. Abdominal macrosetal arrangements. A, dorsal setae. B, ventral setae. C, lateral setae. D, spiracular disc. E, anal papillae, ventral view.

Comparative Notes.—*Tipula nettingi* is closely related to *T. albiprivata* Edwards and *T. dyak* Alexander on the basis of male hypopygium, including especially the short outer basal lobes and the posterior border of eighth sternum simple with short, rounded sides.

Larval Description.—Fourth (final) instar larva: body 46.0–48.0 mm long and 5.5–6.0 mm wide. Body sordid yellow, paler laterally.

Head: broad, massive, a well-sclerotized, typical tipuline head capsule (Byers, 1961; Young, 1981; Gelhaus and Young, 1991). Mandible with one large tooth near base and three to four smaller teeth apically along inner margin. Maxilla with hairy galea and lacinia. Hypopharynx with five short, rounded teeth. Hypostomal bridge with one large, blunt central tooth and four smaller ones on each side.

Body: body of last instar larva stout and terete, tapering gradually toward both ends. Both thorax and abdomen covered with long microscopic hairs perpendicular to body. Thoracic segments also densely covered with fine, shorter microscopic hairs appressed to body. Dark macrosetae located in all segments, with placement as in Figures 2A–C. All setae except L4 are situated on posterior annuli. L4 situated on anterior annulus. Setae D1, D2, D3, D4, V2, V3, V4, L2, and L4 long; D5, L1, and V5 short. Setae D6, L3, and V1 short and branched.

Spiracular disk: surrounded by six subequal spiracular lobes (Fig. 2D), slightly longer than width at base, ventral pair slightly longer than others, lateral pair equidistant from dorsal and ventral pairs. All lobes with well-developed border of setae, margined with brown adjacent to setal bases. Discal surface of upper four lobes sordid yellow, paler along middle of each lobe; ventral lobes each with dark, median longitudinal streak, approximately as long as lobe; below each spiracle one fairly conspicuous black spot. Spiracles large, fuscous brown with blackish centers, separated by distance slightly more than transverse diameter of a spiracle. Four elongate anal papillae (Fig. 2E) with many constrictions along their length; all papillae single; two longer ones curled dorsad around abdomen; two shorter ones extending ventrad.

Remarks.—The larvae of *T. (T.) nettingi* resemble superficially those of Neartic species of the subgenera *Angarotipula*, *Bellardina*, *Nobilotipula*, *Platytipula*, and *Yamatotipula*. They all share the following morphological characters: subequal, long spiracular lobes with long setae; single, dark, median longitudinal streak on ventral lobes; elongate, constricted anal papillae; and branched setae (Gelhaus, 1986). The distinctive difference is the number of anal papillae. Larvae of all the aforementioned subgenera have six anal papillae, while *T. (T.) nettingi* has only four.

Within the genus *Tipula*, the number and shape of the anal papillae provide a characteristic, synapomorphic feature for some subgenera which otherwise display much diversity in larval morphology (Gelhaus, 1986). The current study shows that larvae of *T. nettingi* have a reduced number of four anal papillae compared to six in most aquatic species. Studies of larvae of additional *Tipulodina* species and species belonging to other subgenera are needed to determine the homology of the anal papillae and establish the polarity of the character. One can speculate that a derived feature of *Tipulodina* may well be the apomorphic loss of two anal papillae, and such studies may make it possible to determine which two have been lost.

The size, form, and number of anal papillae are distinctly correlated with larval habitats. They are large, elongate, and more numerous in aquatic species, reduced in size and number in semiaquatic/terrestrial species (Gelhaus, 1986). It has been postulated that the anal papillae provide osmoregulatory and/or locomotory functions (Chiswell, 1956; Brindle, 1957, 1960; Pritchard, 1983). The reduced number of anal papillae found in *T. nettingi* could result from the fluctuation in the amount of water in the larval habitats, as described below in the biology section.

Pupal Description.—Male: length 21–23 mm, width 3.9–4.1 mm. Female: length 29.8–30.2 mm, width 4.8–5.1 mm. Body coloration overall light yellowish brown, slightly darker on tarsal sheaths.

Head: antennal sheath slightly expanded at base (Fig. 3A), apex of sheath reaching about two-thirds length of mesothoracic tibia. Paired short, wrinkled ridges lying between bases of antennal sheaths, with pair of small dorsal papillae. Maxillary palpal sheath short, apex of sheath recurved, reaching sheath of prothoracic femur.

Thorax: respiratory horn (Fig. 3B) length 7.0 mm in male, 10.0 mm in female; minute annulations along entire length of horn; apex flat and rounded. Dorsum of thorax densely wrinkled. Four pairs of short setae on thoracic dorsum above base of wing sheath. Apex of wing sheath nearly reaching end of abdominal segment II. Leg sheaths reaching to posterior venter of abdominal segment IV in male, to anterior venter of abdominal segment IV in female. Apices of all leg sheaths in transverse alignment.

Abdomen: segments II–VII with well-defined anterior and posterior annuli (Fig. 3A, B). Small forked spines present laterally, along posterodorsal margins of all segments, and along basal margins of posterior annuli of segments V–VII. Posteroventral margins of segments III–VII with larger curved spines. Terminal segment (VIII and IX in male; VIII–X in female) with five pairs of elongate spines: two pairs directed dorsally, one pair directed laterally, one pair directed posteriorly, and one pair directed ventrally. Single, short pair of genital sheaths ventral to large posterior spines in male (Fig. 3D). Two pairs of slightly curved, closely appressed genital sheaths between and below posterior spines in female (Fig. 3C).

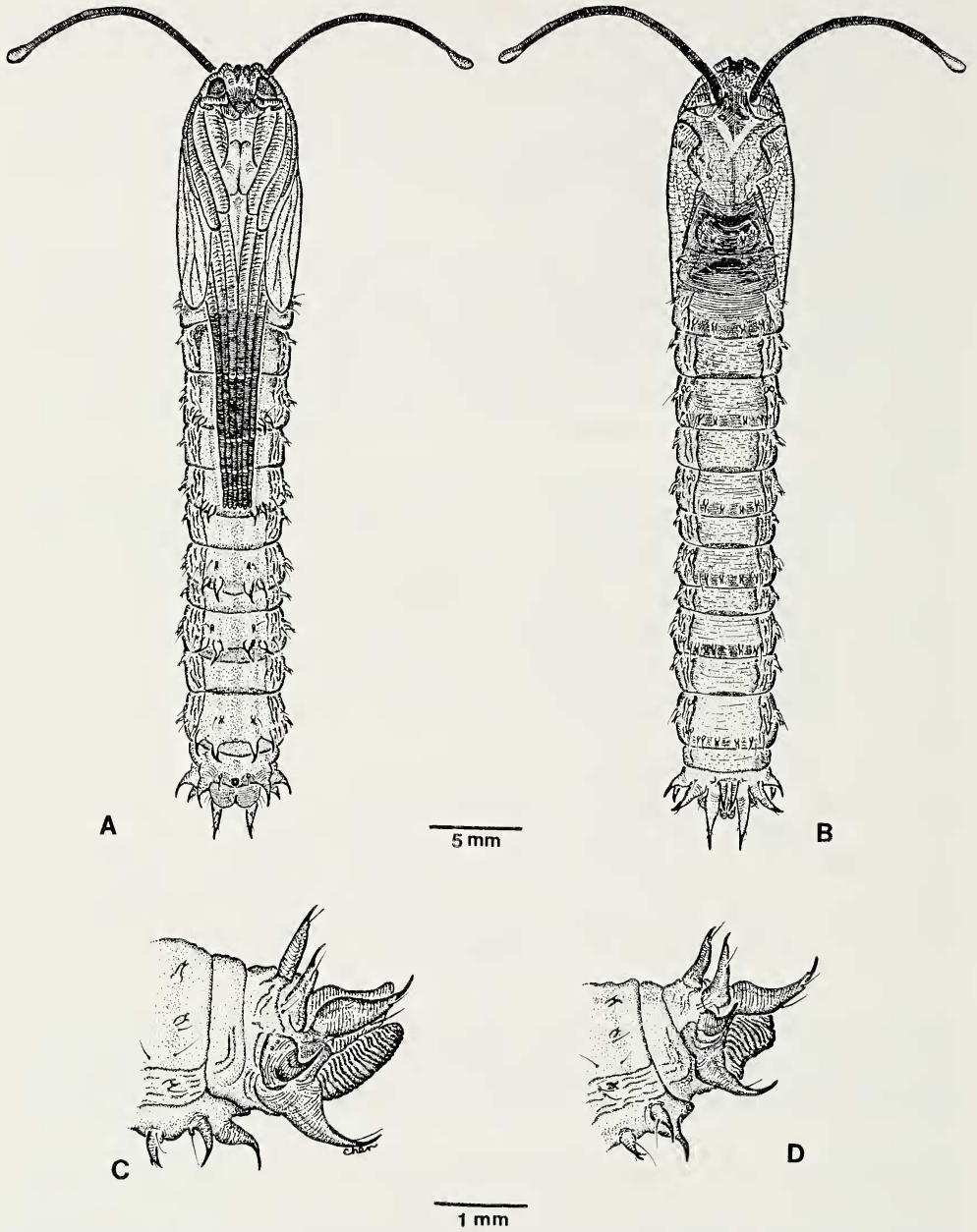


Fig. 3.—Pupae of *T. (Tipulodina) nettingi*. A, ventral view. B, dorsal view. C, female terminal segments, lateral view. D, male terminal segments, lateral view.

Remarks.—The shape of the maxillary palpal sheath, the length of the distal section of the antennal sheath, and the position of the antennal sheath have been analyzed by previous workers attempting to place various lineages of crane flies within the Tipulinae. A straight or curved maxillary palpal sheath, short distal

section of antennal sheath, and apices of antennal and palpal sheaths closely approximated (for example, *Megistocera*, *Brachypremna*, and *Leptotarsus*) are considered plesiomorphic within the Tipulinae (Oosterbroek and Theowald, 1991; Gelhaus and Young, 1995). A strongly recurved apex of the maxillary palpal sheath, an extended distal section of the antennal sheath, and apices of antennal and palpal sheaths widely separated (for example, *Dolichozeza*, *Nobilotipula*, *Platytipula*, and most other Tipulinae) are considered apomorphic (Gelhaus and Young, 1995). The present study of the pupal characters of *T. nettingi* shows its resemblance to most of the species of the advanced lineages of Tipulinae.

The size and form of the respiratory horns of the pupa of *T. nettingi* are probably specifically associated with pupal habitats. Elongate respiratory horns are also present in several other unrelated aquatic species of *Angarotipula* and *Lep-totarsus*, within Tipulinae.

Biology.—All specimens used in this study were collected at a rain-forest site within the Dumoga-Bone National Park on the northern peninsula of Sulawesi. The National Park is located just north of the equator (0°38'N, 124°06'E). The vegetation of the site is primary lowland forest at approximately 200 m elevation. Larvae were collected in rotted stumps of the palm *Livistona rotundifolia*. The palm stumps were about 1 m high with small pools of water in the center. Many of the stumps showed evidence of habitation by termites in the more basal parts. Larvae could be located when they opened the spiracular lobes and exposed the caudal end to the surface of the water for breathing. They moved quite swiftly by extension and contraction of the body. When the outside wall of the stump was tapped gently, the larvae withdrew both the spiracular lobes and the head capsule and remained motionless for several minutes. Larvae withdrew and moved briskly by undulation when the stump was suddenly, vigorously vibrated. In one of the stumps, where the water inside had receded, larvae were found buried to about 8–12 cm below the surface where the substrate was still very wet.

Larvae for rearing were transported back to the field laboratory and kept in a 32 × 24 × 11-cm transparent plastic box. Water and organic substances from the natural habitat were mixed and covered the bottom of the box to a depth of 5 cm. Broken pieces of decomposed palm pith were added to one end of the box to simulate the natural habitat. Pupae attached themselves vertically to the wall of the palm with the tips of the respiratory horns protruding out of the water. When disturbed, they wriggled vigorously and withdrew completely into the water. They resumed their partially emergent posture when left undisturbed for a few minutes. Duration of the pupal stage was about ten days.

Pupae of other *Tipulodina* species have also been reported from other kinds of phytotelmata in similar habitats. Pupae of *T. (T.) brunettiella* Alexander were collected from bamboo stumps in India (Edwards, 1932). I collected one callow female of *T. (T.) taiwanica* (Alexander) from a hollow bamboo stump in Taiwan. Within the study area, one female of the new species described below, *Tipula (Tipulodina) phasmatodes*, was observed to deposit eggs in a flooded cavity in a fig tree. Larvae and pupae of an undescribed species were also collected by Byers from a tree hole in Korea. Byers speculated that the larvae of *Tipulodina* in Korea probably fed on mosquito larvae which inhabited the same tree hole (George Byers, personal communication), since these larvae quickly disappeared from a laboratory jar also containing *Tipulodina*. It is conceivable that with limited accessible food resources in a phytotelmaton, the usually herbivorous larvae will occasionally become carnivorous opportunists.

Tipula (Tipulodina) phasmatodes Young, **new species**
(Fig. 1C, D, F)

Description.—Body length: male, 20 mm; female, 26 mm. Wing length: male, 19 mm; female, 20 mm.

Head: rostrum short, grayish brown, sides with dark brown stripe. Nasus distinct, about one-half length of rostrum. Occiput brown, anterior vertex with a small, dark brown, erect median tubercle between eyes. Palpi yellowish brown. Antenna 6 mm in male, 3.5 mm in female; scape, pedicel pale brown, flagellomeres dark brown, basal enlargements conspicuous with four to five verticils; verticils subequal to segment length in both sexes.

Thorax: pronotum dark brown medially, yellowish brown laterally. Prescutum yellowish brown with three poorly defined stripes; central stripe with dark, narrow median line. Scutum, scutellum, and parascutellum grayish brown. Postscutellum grayish brown. Wings grayish subhyaline, with dark brown area including apex in outer radial cells and with conspicuous dark seams on anterior and posterior cord; outer medial veins narrowly seamed with brown; stigma dark brown, confluent with seam at cord; a distinct, large, brown quadrate spot before middle of cell *bm* along vein *CuA*. Halteres dark brown. Legs with coxae and trochanters light yellow; femora brownish yellow, outer one-fourth more whitened to form long diffuse ring; fore and middle tibiae brownish black with long white ring at midlength; hind tibiae black with two white rings between proximal and terminal dark rings; basitarsi with basal half brown and terminal half white; remaining tarsomeres white except pretarsi brown.

Abdomen: terga chestnut brown with brownish black subterminal band, extreme posterior borders narrowly yellow; sterna yellowish brown.

Male hypopygium: external structures as in Figures 1C and D. Posterior border of tergum IX slightly emarginate with lateral angles produced as flat lobes bearing abundant black setae. Outer dististyle large, oval, flattened. Inner dististyle with beak flattened, slender, directed anteriorly; lower basal lobe of inner dististyle fingerlike, apex with long, dark setae; outer basal lobe long, curved outward from base, gradually into long, recurved, black terminal spine. Sternum VIII with posterior border produced into long, triangular blade.

Ovipositor: external structures as in Figure 1E. Cerci subequal in length to tergum X, broad from base to midlength and then narrowed toward upwardly curved apex. Hypovalvae reaching to about midlength of cerci, base of hypovalvae expanded upward. Sternum IX with distinct, sclerotized side lobes and median fused valvulae. Sternum X with long, dense setae.

Type Material.—Holotype: male, CMNH. Verbatim text of three pin labels: INDONESIA Sulawesi Utarra Dumoga-Bone N. P. 4 Sept. 1985 Coll. Chen Young / R2 Toraut 211 m PROJECT WALLACE / HOLOTYPE *Tipula (Tipulodina) phasmatodes* Young [red paper]. Paratypes: two males and one female, topotypic, males collected on 24 August and 3 September 1985; female collected on 7 September 1985; one male, 21 January 1985, collected by J. Holloway.

Etymology.—The name of this species is the Greek adjective *phasmatodes*, meaning phantomlike, and refers to the ghostly appearance that the black-and-white banded legs give to the adult flies when on the wing.

Comparative Notes.—The general appearance of *T. (T.) phasmatodes* is similar to that of *T. nettingi*. These two species can be distinguished by color pattern of hind tibia. In *T. phasmatodes* the hind tibia with black center between two white rings, while in *T. nettingi* it is white center between two black rings. The nearest relatives of the present fly include *T. felicitata* Alexander, *T. fuscitarsis* Edwards, and *T. pedata* Wiedemann, each with the structure of the male hypopygium distinct, including especially the elongated outer basal lobes and the posterior border of eighth sternum produced into long, triangular blade.

Mate-searching Behavior.—Mate-searching behavior of adult males of Tipulinae has been described as walking or flying over the ground, up tree trunks, or among vegetation (Pritchard, 1983). Attraction to the same resting area and swarming also brings males and females into close proximity (Byers, 1961). Males of both species in this study performed a downward, searching behavior on tree trunks. The male started its search on the tree trunk about two meters off the

ground and performed a series of vertical oscillating flights around and toward the base of the trunk. It then flew to the next tree trunk and repeated the same search pattern. Males do not limit their searches to trunks or stumps of the palm *Livistona rotundifolia* usually inhabited by the larvae and pupae. Actual copulation was not observed in nature.

ACKNOWLEDGMENTS

This paper is Project Wallace Paper No. 145 and is based on specimens collected by the author on Project Wallace, sponsored by the Indonesian Institute of Science and the Royal Entomological Society of London. The research was supported by a grant from the M. Graham Netting Field Research Fund, the Carnegie Museum of Natural History, Pittsburgh, Pennsylvania. I would like to thank J. E. Rawlins and R. L. Davidson for suggestions on the manuscript; thanks also to three anonymous reviewers for their comments.

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